Silicon Carbide Mounts for Fabry-Perot Interferometers

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Etalon mounts for tunable Fabry-Perot interferometers can now be fabricated from reaction-bonded silicon carbide structural components. These mounts are rigid, lightweight, and thermally stable. The fabrication of these mounts involves the exploitation of post-casting capabilities that (1) enable creation of monolithic structures having reduced (in comparison with prior such structures) degrees of material inhomogeneity and (2) reduce the need for fastening hardware and accommodations. Such silicon carbide mounts could be used to make lightweight Fabry-Perot interferometers or could be modified for use as general lightweight optical mounts.

Heretofore, tunable Fabry-Perot interferometer structures, including mounting hardware, have been made from the low-thermal-expansion material Invar (a nickel/iron alloy) in order to obtain the thermal stability required for spectroscopic applications for which such interferometers are typically designed. However, the high mass density of Invar structures is disadvantageous in applications in which there are requirements to minimize mass.

Silicon carbide etalon mounts have been incorporated into a tunable Fabry-Perot interferometer of a prior design that originally called for Invar structural components. The strength, thermal stability, and survivability of the interferometer as thus modified are similar to those of the interferometer as originally designed, but the mass of the modified interferometer is significantly less than the mass of the original version.

This work was done by Scott Lindemann of Michigan Aerospace Corp. for Goddard Space Flight Center. For further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810. GSC-14957-1

Measuring the In-Process Figure, Final Prescription, and System Alignment of Large Optics and Segmented Mirrors Using Lidar Metrology

This technique has application in commercial optics and lithography.

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The fabrication of large optics is traditionally a slow process, and fabrication capability is often limited by measurement capability. While techniques exist to measure mirror figure with nanometer precision, measurements of large-mirror prescription are typically limited to submillimeter accuracy. Using a lidar instrument enables one to measure the optical surface rough figure and prescription in virtually all phases of fabrication without moving the mirror from its polishing setup. This technology improves the uncertainty of mirror prescription measurement to the micron-regime.

Furthermore, during instrument assembly, a lidar instrument measures the fabricated optical surface directly and compares with scans of diffuse, mechanical surfaces or other coordinate system references on metering structures. This speeds the alignment process and removes the necessity of ancillary alignment fiducials because the optical surface can be sampled directly.

The commercial lidar system illuminates a target surface with a focused, near-IR beam. The instrument collects scattered light returned from the target and optically mixes it with a reference signal maintained within the instrument, obtaining range data. The energy is directed from the instrument to any target within a field of regard spanning >360° in azimuth and ±45° in elevation and ranging ≈60 m. The uncertainty in range is typically ≈15 microns and <1 arcsec in angle. Since the instrument can detect faint, scattered radiation, it can be used to detect errors directly in the surface figure and prescription of an optic during in-process fabrication, when the surface is rough. Since the surface will have a matt or ground finish, this measurement can be accomplished without necessarily locating the lidar instrument in any special location with respect to the mirror, as long as it has sufficient line of sight to the surface.

The lidar would scan the surface using a preprogrammed grid of sample points that could be arbitrary or have a relationship to the mirror edges. As the mirror progresses through grinding into polishing phases, the surface becomes more specular. In order to detect fabrication errors in the figure and prescription at this stage, the lidar must be located close to the center of curvature of the optic. The tolerance for this location can be derived from the field of view of the lidar's camera and the approximate prescription of the optic under test, but is typically of-order centimeters. The lidar's camera similarly limits the detectable aspheric departure.

The location tolerance was generous and could be accomplished by locating the lidar unit using a simple tape measure. For mirrors with glass substrates, during lidar measurement in the polishing phase when the surface is approximately specular, one would need to apply a temporary coating to the surface under test using, e.g., a spray-on type coating applicator already in common use in optical shops. (Alternatively, cus-

tom software could be used to filter the range data to select the return from the dimmer surface.) Mirrors with metal substrates would need no such temporary coating during the lidar measurement in the polishing phase. Since the instrument can also detect bright, specularly returned radiation, it can be used to directly characterize the as-built prescription of large optics after polishing and coating. The lidar must be positioned near the center of curvature (but only to within the loose tolerance described above). The lidar would scan the surface using a preprogrammed grid of sample points.

In a similar manner, the lidar may be used for the coarse alignment and phasing of segmented telescope primary mirrors for future, large space- and ground-based observatories. Located near the nominal center of curvature, the segments are scanned and iteratively aligned to microns, where other, interferometric or image-based techniques would be used to complete fine alignment.

This work was done by Raymond Ohl of Goddard Space Flight Center, Anthony Slotwinski of Pyxisvision, and Bente Eegholm and Babak Saif of the Space Telescope Science Institute. Further information is contained in a TSP (see page 1). GSC-15988-1